

NOTE ON THE VERTEBRAL COLUMN OF THE BUSHMAN RACE OF SOUTH AFRICA.

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The study of the relative position of man in nature, and of the different races of mankind to each other according to their bodily structure, civilization, and culture, is one in common with all other sciences, which call for further investigation and accumulation of data. Especially is this true of those races which are believed to occupy a low morphological position, such as the Bushman race of South Africa.

During last year, 1913, Miss Winifred Tucker, B.A., in course of an anthropological survey in the Richtersveld procured three skeletons, and kindly presented these to the Anatomical Department of the South African College, forming the nucleus of an osteological museum.

Two of the skeletons (numbered S.A.C. 1 female, and S.A.C. 2 male), are almost complete and in excellent preservation. They are traditionally Bushman skeletons, and were found curled round with the hands lying close to the chin, and with the knees drawn up; otherwise there was no special orientation to be observed in the mode of burial. From all the indications, Miss Tucker was of opinion that they were Hottentot graves, but as the Hottentots still bury their dead in the outright position, they were quite indignant when asked if they knew of no other way.

The third skeleton (numbered S.A.C. 3 male) was found exposed near the mouth of the Orange River. The bones are consequently bleached and fragile, a few of the bones having partly crumbled away.

The researches of Mr. Shrubsall* have clearly shown that the Bushman race of South Africa could be divided into two distinct classes—the Strandlooper and Inland Bushman, the Strandlooper being a more homogeneous group than the Inland Bushman, which would appear to be

* Shrubsall, "Annals of South African Museum," vol. 5.

intermediate between the Strandlooper and the Hottentot. In order to satisfy myself regarding the three skeletons under observation, I have made careful investigation of them, and have found that according to Shrubsall's methods and tables they would appear to fall into the intermediate group between the Strandloopers and Hottentots, and to which Cunningham* has given the name of Hottentot-Bushman.

Few regions, indeed, of the skeletons of the South African Bushman have failed to give evidence of distinct racial character; thus the crania with regard to their capacities and indices have been carefully examined by many observers and found to present characteristic racial structure. The same holds good of the vertebral column, especially in its lumbar and sacral regions, as well as many of the bones of the upper and lower limbs.

In this paper it is proposed to deal with the vertebral column, and although the number of specimens is small, still, certain points in the cervical and thoracic regions appear to be possibly of some importance for verification by examination of further material. With regard to the lumbar and sacral regions, the results help to swell the necessary data for a satisfactory definite classification. For purposes of comparison I have examined the vertebral column in three European skeletons, the various measurements and indices being compared with one another.

Cervical Region. Vertebrae Cervicales.

The centrum and vertebral foramen each lend themselves to measurement, and the following indices have been constructed.

Corpus.—The antero-posterior length is taken through the centrum from front to back at points equidistant from the upper and lower borders: the breadth or transverse diameter—from the central point between the anterior and posterior roots of the processus transversus medial to the foramen transversarium on the caudal aspect of the bone, the callipers being most conveniently adjusted at this point; the depth—from the centres of the corpus on the cranial and caudal surfaces.

$$\text{Length-Breadth Index} = \frac{\text{Length} \times 100}{\text{Breadth}}$$

$$\text{Length-Depth Index} = \frac{\text{Depth} \times 100}{\text{Length}}$$

Foramen Vertebrae.—The antero-posterior length is measured from the upper border of the posterior surface of the corpus to the centre of the

* Cunningham, "Memoirs II."

upper edge of the arcus vertebræ opposite; the breadth—between the medial aspects of the pedicles (radix arcus vertebræ).

$$\text{Length-Breadth Index} = \frac{\text{Length} \times 100}{\text{Breadth}}$$

EUROPEAN. CERVICAL VERTEBRÆ. CORPUS.

No. of Vertebra.	No. 1.			No. 2.			No. 3.		
	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.
2	14	29	35	14	24	31	13	25	33
3	16·5	26	12	13	21·5	10	16	24	11
4	16	25	11	12	22	11	14	26	10
5	15·5	29	11	14	26·5	10	17	26	11
6	18	32	11	16	28	12	16	27	10
7	19	35	12	14	29	10	15	30	11
Total	99	176	92	83	151	84	91	158	86
Length-Breadth Index, 56·3 Length-Depth Index, 92·9				Length-Breadth Index, 54·9 Length-Depth Index, 100·2			Length-Breadth Index, 57·6 Length-Depth Index, 94·5		

Average Length-Breadth Index, 56·26.
Average Length-Depth Index, 95·8.

BUSHMAN. CERVICAL VERTEBRÆ. CORPUS.

No. of Vertebra.	No. 1.			No.			No. 3.		
	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.
2	10	24	29	11	21	25	13	24	30
3	12	21	8	12·5	18	7	—	—	—
4	11	22	9	12	20	8·5	—	—	—
5	11	22	8·5	11	21	8·5	—	—	—
6	12	24	8·5	12	24	9	—	—	—
7	12	26	9	12	26	9·5	16	28	11
Total	68	139	72	70·5	130	67·5	—	—	—
Length-Breadth Index, 48·9 Length-Depth Index, 105·8				Length-Breadth Index, 54·2 Length-Depth Index, 95·7					

Average Length-Breadth Index, 51·5.
Average Length-Depth Index, 100·7.

EUROPEAN. CERVICAL VERTEBRAE. VERTEBRAL FORAMEN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
1	19	29	21	28	21	29
2	17·5	22	18	24	20	24
3	15	20	14	24	15	23
4	15	23	15	25	14	24
5	14·5	25	13	25	15	24
6	14	24	13	27	15	25
7	15	24	14	26	15	25
Total ..	110	167	108	179	115	174
Length-Breadth Index, 65·8			Length-Breadth Index, 60·3		Length-Breadth Index, 66	

Average Length-Breadth Index, 64·03.

BUSHMAN. CERVICAL VERTEBRAE. VERTEBRAL FORAMEN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
1	20	25	20	26	—	—
2	19	22	17	21	—	—
3	14	21	15	21	—	—
4	13	21	15	22	—	—
5	14	22	15	22	—	—
6	13	22	14	22	—	—
7	13	21	13	21	—	—
Total ..	106	154	109	155	Bones Defective	
Length-Breadth Index, 68·8			Length-Breadth Index, 70·3			

Average Length-Breadth Index, 69·5.

A comparison of these indices would appear to show that in the Bushman the bodies of the vertebrae were relatively narrower in their antero-posterior length and deeper in their vertical depth than in the European by about 5 per cent. in each case. The vertebral foramen is relatively longer in the Bushman, thus corresponding with the length-breadth index of the skull, which gives an indication of the relative dimensions of the cranial cavity.

Of the other parts of the Bushman cervical vertebrae the non-bifid and less obliquely inclined spinous processes are distinctive, while the interlocking arrangement of the bodies appears to be somewhat poorly developed as compared with those of the European.

Thoracic Region. Vertebrae Thoracales.

The antero-posterior diameter (length), transverse diameter (breadth), and vertical depth of the bodies are taken at the centres of the bodies from front to back, from side to side, and from above to below respectively. The vertebral foramen is measured as in the cervical vertebrae, and the indices are similarly arranged.

EUROPEAN. THORACIC VERTEBRAE. CORPUS.

No. of Vertebra.	No. 1.			No. 2.			No. 3.		
	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.
1	18	28	15	15	28	12	16	29	15
2	19	26	15	17	26	13	17	28	16
3	20	23	17	20	23	14	19	26	17
4	22	23	18	21	22	15	21	24	18
5	23	25	18	22	22	15	22	25	19
6	26	26	18	23	24	16	24	27	20
7	29	28	19	24	25	16	26	28	21
8	31	30	18	25	27	17	29	29	21
9	31	31	19	26	28	18	30	31	21
10	30	32	20	26	29	18	29	31	22
11	30	35	21	26	31	18	28	35	22
12	30	38	23	27	32	20	30	38	25
Total	309	345	221	272	317	192	291	351	237
Length-Breadth Index, 89·5			Length-Breadth Index, 85·8			Length-Breadth Index, 82·9			
Length-Depth Index, 71·2			Length-Depth Index, 70·5			Length-Depth Index, 81·4			

Average Length-Breadth Index, 86·06.

Average Length-Depth Index, 74·3.

BUSHMAN. THORACIC VERTEBRAE. CORPUS.

No. of Vertebra.	No. 1.			No. 2.			No. 3.		
	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.
1	13	24	12	14	24	11	—	—	—
2	14	25	12	15	24	11	—	—	—
3	15	22	12·5	16	22	12	—	—	—
4	16	21	13	17	21	13	—	—	—
5	18	20	14	17	20	14	—	—	—
6	19	20	15	18	21	14	—	—	—
7	20	21	15	20	22	14	—	—	—
8	21	20·5	15	21	22	15	—	—	—
9	21	21·5	15·5	21	23	15	—	—	—
10	22	22	16	21	24	15	26	28	18
11	22	24	17	22	25	15	25	35	20
12	21	25	18	21	27	16	25	37	21
Total	222	266	175	223	275	165	—	—	—
Length-Breadth Index, 83·4			Length-Breadth Index, 80·1						
Length-Depth Index, 78·8			Length-Depth Index, 74						

Average Length-Breadth Index, 81·7.

Average Length-Depth Index, 76·4.

EUROPEAN. THORACIC VERTEBRAE. VERTEBRAL FORAMEN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
1	15	20	14	21	16	23
2	16	18	14	18	16	19
3	16	17	15	15	16	17
4	17	17	15	15	17	17
5	17	17	15	15	17	17
6	16	17	15	15	16	17
7	16	17	15	15	16	17
8	16	17	15	16	16	17
9	16	18	14	17	16	18
10	16	18	14	17	16	18
11	17	19	15	18	16	17
12	16	22	16	21	16	19
Total ..	194	217	177	203	194	216
Length-Breadth Index, 89·4			Length-Breadth Index, 87·1		Length-Breadth Index, 89·8	

Average Length-Breadth Index, 88·7.

BUSHMAN. THORACIC VERTEBRAE. VERTEBRAL CANAL.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
1	13	18	13	13	—	—
2	14	16	14	17	—	—
3	14	16	14	15	—	—
4	14	16	14	14	—	—
5	14	15	14	15	—	—
6	14	15	14	15	—	—
7	14	15	14	15	—	—
8	15	16	15	15	—	—
9	15	17	15	15	—	—
10	15	17	15	16	—	—
11	15	18	15	16	—	—
12	15	19	16	18	—	—
Total ..	172	198	173	189	—	—
Length-Breadth Index, 86·8		Length-Breadth Index, 91·5				

Average Length-Breadth Index, 89·1.

The indices show that, as in the cervical vertebrae, the bodies of the thoracic vertebrae are relatively shorter and deeper in the Bushman, but not to such a marked degree. The vertebral foramina do not, owing to their almost circular shape, show much difference. Of the other parts of

the vertebrae, the spinous process and lamina overlap each other in a much lesser degree in the Bushman, thereby allowing a greater latitude of movement in the thoracic region.

Lumbar Region. Vertebrae Lumbales.

The various measurements of the bodies and canals are taken as in the thoracic vertebrae, and the general lumbar index which indicates the amount of curvature of the spine in this region as far as the vertebrae are concerned is also added; thus:—

$$\frac{\text{Sum of Posterior Vertical Diameters of the Bodies}}{\text{Sum of Anterior Vertical Diameters of the Bodies}} \times 100.$$

EUROPEAN. LUMBAR VERTEBRAE. CORPUS.

No. of Vertebra.	No. 1.			No. 2.			No. 3.		
	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.
1	29	38	25	26	34	21	31	40	27
2	29	38	24	26	34	21	32	42	23
3	31	39	25	27	35	22	33	43	24
4	32	41	24	27	36	23	34	44	23
5	31	42	22	27	38	22	34	46	22
Total	152	198	120	133	177	109	164	215	119
Length-Breadth Index, 76·7			Length-Breadth Index, 75·1			Length-Breadth Index, 76·2			
Length-Depth Index, 79			Length-Depth Index, 82			Length-Depth Index, 72·5			

Average Length-Breadth Index, 76.
Average Length-Depth Index, 77·8.

BUSHMAN. LUMBAR VERTEBRAE. CORPUS.

No. of Vertebra.	No. 1.			No. 2.			No. 3.		
	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.	Length.	Breadth.	Depth.
1	21	27	18	22	28	19	26	38	23
2	22	29	20	23	28	20	27	36	23
3	23	31	20	24	30	21	29	40	23
4	25	33	20	26	34	21	32	42	21
5	25	34	19	27	32	20	32	45	22
Total	116	154	97	122	152	101	146	201	112
Length-Breadth Index, 75·3			Length-Breadth Index, 80			Length-Breadth Index, 70·2			
Length-Depth Index, 83·6			Length-Depth Index, 82·8			Length-Depth Index, 76·7			

Average Length-Breadth Index, 75·2.
Average Length-Depth Index, 81·03.

EUROPEAN. LUMBAR VERTEBRAE. VERTEBRAL FORAMEN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
1	16	22	16	21	15	21
2	14	21	15	22	14	22
3	15	21	14	22	13	21
4	15	22	13	21	13	22
5	15	22	14	21	14	23
Total ..	75	108	72	107	69	109
Length-Breadth Index, 69·4			Length-Breadth Index, 67·2		Length-Breadth Index, 63·3	

Average Length-Breadth Index, 66·6.

BUSHMAN. LUMBAR VERTEBRAE. VERTEBRAL FORAMEN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
1	14	20	16	18	15	18
2	14	20	15	19	13	18
3	15	21	14	19	11·5	18
4	15	21	15	19	11·5	18
5	16	22	16	21	12	19
Total ..	74	103	76	96	63	91
Length-Breadth Index, 71·8			Length-Breadth Index, 68·7		Length-Breadth Index, 69·2	

Average Length-Breadth Index, 69·9.

General Lumbar Index of the Vertical Anterior and Posterior Diameters of the Lumbar Bodies.

EUROPEAN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Anterior.	Posterior.	Anterior.	Posterior.	Anterior.	Posterior.
1	25	27	24	25	24	27
2	26·5	26·5	25	25	27	26·5
3	28	27	26	25	29	26
4	28	25	27	25	30	24
5	28	20	29	23	30	20
Total ..	135·5	125·5	131	123	140	123·5

Sum total of Anterior Vertical Diameters, 406·5.

Sum total of Posterior Vertical Diameters, 372.

General Lumbar Index 91·5.

BUSHMAN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Anterior.	Posterior.	Anterior.	Posterior.	Anterior.	Posterior.
1	21·5	22	22	21·5	22·5	26
2	23	23	22	22	23	25
3	23	23	24	23	24	25
4	24	22	24	23·5	23	23
5	23	20	24·5	22	24	22
Total ..	114·5	110	116·5	112	116·5	121

Sum total of Anterior Vertical Diameters, 347·5.

Sum total of Posterior Vertical Diameters, 343.

General Lumbar Index 98·7.

The difference in the antero-posterior length of the bodies of the lumbar vertebrae in the European and Bushman is practically negligible, but the central vertical depth of the bodies and the antero-posterior length of the vertebral canals are much greater in the Bushman.

The average of the indices of the vertical diameters of the bodies show a decided difference; thus the European average is 91·5, while the Bushman average is 98·7.

The different races of man have been classified according to this index, thus:—

Kurtorachic—index below 98, displaying a forward convexity; includes Europeans generally, and Chinese.

Orthorachic—index between 98 and 102, column practically straight; includes examples of Eskimo and Maori.

Koilorachic—index above 102, displaying a backward convexity, includes Australians, Negroes, Bushmen, and Andamanese.

It will thus be noted that hitherto the South African Bushman has been placed in the *Koilorachic* class. Shrubsall's observations (1) pointed out that in the specimens he examined they fell into the second class with straighter spines as far as the bones are concerned.

The present series would seem to support Shrubsall's observations.

In the literature at my disposal I have not observed evidence of inquiry into a similar arrangement as far as the cervical and thoracic vertebral curves are concerned. I have therefore constructed a similar index of the vertical anterior and posterior depths of the bodies of the cervical and thoracic vertebrae.

The following tables would appear to show that the same characteristic as in the lumbar region, namely, that there is no adaptation of the bones

to the curves, obtains in the cervical and thoracic regions as well. The adaptation must therefore in the South African Bushman be entirely cartilaginous, for there is reason to believe that the lower races have as strongly developed curves when erect as the higher races. The only proof afforded as yet are Cunningham's section of an Australian spine, and his index of ensellure on living Bush natives. What, it may be asked, does the differences in construction, namely, (1) cartilaginous arrangement, (2) less obliquely placed laminae and spines, (3) narrowness of the bodies in an antero-posterior direction, mean? In higher races the spine has sacrificed flexibility for stability. Lower races have preserved the suppleness essential for their mode of life and needs, hence in the maintenance of the erect attitude the ligamentous and muscular mechanism must be brought more into play than in higher races.

Cervical Vertebrae.

Anterior and Posterior Vertical Diameters of the Bodies.

EUROPEAN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Anterior.	Posterior.	Anterior.	Posterior.	Anterior.	Posterior.
3	14	14	13	12	13	13
4	13	12	13	12	10	11·5
5	14	13·5	11	12	14	12
6	14	14·5	13·5	14	13	13
7	14	15	13	13	13·5	14
Total ..	69	69	63·5	63	63·5	63·5

Sum total of Anterior Vertical Depths, 196·5.

Sum total of Posterior Vertical Depths, 195·5.

Index 99·9.

BUSHMAN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Anterior.	Posterior.	Anterior.	Posterior.	Anterior.	Posterior.
3	10	10·5	9	10	—	—
4	10	10	10	10	—	—
5	10	10·5	10	10	—	—
6	10	10·5	10	10	—	—
7	11	11·5	11	10·5	—	—
Total ..	51	53	50	50·5	—	—

Sum total of Anterior Vertical Depths, 101.

Sum total of Posterior Vertical Depths, 103·5.

Index 102·5.

Thoracic Vertebrae.

Anterior and Posterior Vertical Diameter of Bodies.

EUROPEAN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Anterior.	Posterior.	Anterior.	Posterior.	Anterior.	Posterior.
1	16·5	17	14	14·5	16	16·5
2	17	17·5	16	17	18	19
3	17	18	17	17·5	20	20
4	18	19	18	18	20	20
5	18	19	18	19	20	21
6	18	20	18	20	21	22
7	17	20	18	19·5	20	22
8	16	20	18	20	19	22
9	18	20	20	22	21	22
10	20	22·5	20	21	23	23
11	21	24	20	22·5	24	25
12	23	26	22	24	23	28
Total ..	219·5	243	219	236	245	260·5

Sum total of Anterior Vertical Depths, 683·5.

Sum total of Posterior Vertical Depths, 739·5.

Index 108·2.

BUSHMAN.

No. of Vertebra.	No. 1.		No. 2.		No. 3.	
	Anterior.	Posterior.	Anterior.	Posterior.	Anterior.	Posterior.
1	13	13·5	12	11·5	—	—
2	14	14	14	13	—	—
3	16	15	15	14	—	—
4	16	15	16	15	—	—
5	16·5	16	16	17	—	—
6	17	16·5	17	18	—	—
7	18	17	18	18	—	—
8	18	18	18	18	—	—
9	18	18	19	18·5	—	—
10	19	19	19	18·5	21	21
11	19	20	19	20	20	22
12	20	21	20	19	21·5	23
Total ..	204·5	203	203	201·5	—	—

Sum total of Anterior Vertical Diameters, 407·5.

Sum total of Posterior Vertical Diameters, 404·5.

Index 99·2.

Sacrum.

The measurements and indices utilized in the study of the sacrum are as follows :—

1. Sacral Index =

$$\frac{\text{Breadth of base of sacrum} \times 100}{\text{Length from middle of promontory to middle of anterior-inferior border of fifth sacral vertebra.}}$$

The length is measured with callipers, but Cunningham (Glasgow, 1900) pointed out that this could not be regarded as the true length, for it did not take into account the curve of the sacrum, often a very considerable factor and showing racial character. He therefore suggested that the length should be measured from the points mentioned above along the concavity with a steel tape held in position by a flexible strip of lead. I append a table from Professor Cunningham's Lectures to his class of Anthropology in Edinburgh University, of which I was a member, showing the differences between the indices constructed from the callipers and tape measurements, and how the index largely depends on the condition of the curve.

	Calliper Index.	Tape Index.	Curve Index.
Irish Female, A	125.7	108	19.4
Irish Female, B	158.3	110	32
Irish Male, A	110	96.6	22.5
Irish Male, B	126.7	98.4	28
Torres Straits Male	108	100	17.5
Torres Straits Female	115	101.8	19.5
Andaman Male	118.7	106.3	17.8
Negro	103.5	97.5	11.5
Australian	89	86.6	11.6
Chimpanzee	82.5	80.6	5.6

2. Sacral Curve Index =

Depth of curve from deepest part of curve to line joining middle of promontory to middle of anterior inferior border of fifth vertebra $\times 100$.

The length of curve measured by flexible tape.

SACRAL INDEX.

	S.A.C. 1. Female.	S.A.C. 2 Male.	S.A.C. 3. Male.
Sacral Length, Callipers.. ..	99	93	103
Sacral Length, Tape	106	98	105
Sacral Breadth	99	94	92
Callipers Index	100	101	89.3
Tape Index	93.4	95.9	87.6

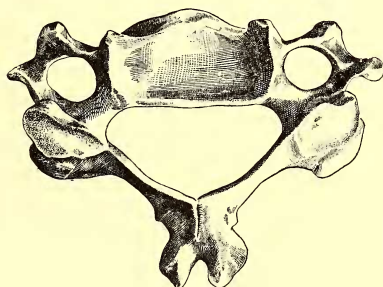
SACRAL CURVE INDEX.

	S.A.C. 1. Female.	S.A.C. 2. Male.	S.A.C. 3. Male.
Length of Curve, Tape	106	98	105
Depth of Curve	20	16	12.5
Index	18.8	16.3	11.9

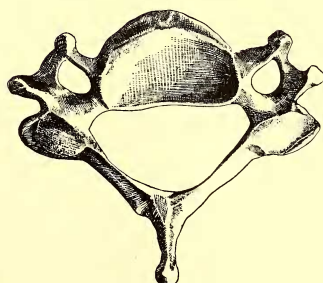
Average Index in S.A. Bushman, 15.6

Compare with Cunningham's Table:--

Irish Females (2)	25.7
Irish Males (2)	25.2
Torres Straits Male	17.5
Torres Straits Female	19.5
Andaman Male	17.8
Negro	11.5
Australian	11.6
Chimpanzee	5.6

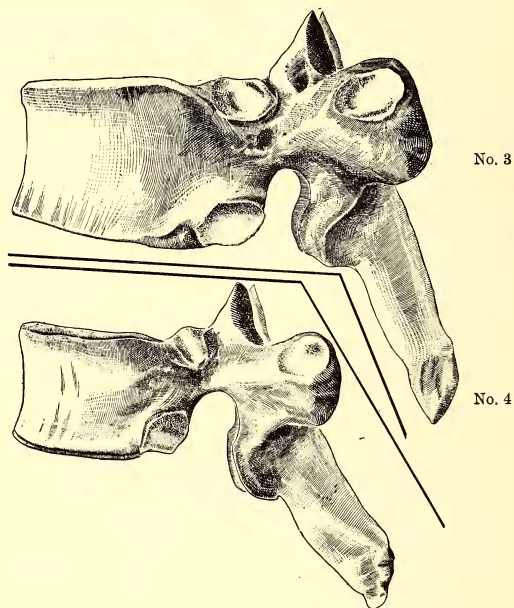


No. 1



No. 2

No. 1 European, and No. 2 Bushman, fifth cervical vertebra, illustrating differences in the spinous processes, bodies, and the vertebral foramina.



No. 3 European, and No. 4 Bushman, eight thoracic vertebrae, illustrating differences in the vertical anterior and posterior diameters of the bodies, and also the relatively less oblique direction of the laminae and spinous processes in the Bushman as shown by the angles between the lines projected through the centres of the bodies and spinous processes.